Network Service Orchestration for Multi-Vendor NFVI

1. The Market Landscape

Several factors have jointly contributed to the increased demand for cloud-based managed network services.

a. Explosive Demand for Web-based Services and Enterprise Applications

The phenomenal growth in the consumption of web-based services such as online commerce whose market is expected to reach USD$1.78 billion by 2020[1] and online gaming whose market tripled in 10 years to USD41.4 billion in 2015[2] has resulted in a strong surge in the demand for computing, storage and network services. The surge is also contributed by a burgeoning Enterprise Applications market that is estimated to be worth USD$259.5[1] billion by 2022[3].

b. Move to Cloud

More and more Enterprises are adopting leaner operating models for their IT management and are shifting to the Cloud. Worldwide spending on public cloud services is expected to grow at a 19.4% CAGR over the next 4 years to USD$141 billion in 2019[4] as Enterprises reduce their Total Cost of Ownership(TCO) on hardware and as newer, innovative solutions for managing shared IT resources are introduced in the marketplace.

c. Use of Virtualized Architecture

Virtualization is becoming the central theme to modernization of Enterprise IT systems and infrastructure as Enterprises seek means to drive operational agility and accelerate their speed to market. Software Defined Networking(SDN) which redefines the storage and computing architecture by decoupling the network control from forwarding functions is seeing increased adoption across data centers, campuses and service provider environments, with the market forecast to reach US$8.7 billion in 2020[5], as it helps Enterprises move towards agility, scalability and away from 'vendor lock-in'.

At the same time, Network Functions Virtualization (NFV) is seeing early deployments by service providers around the world as they move network functions to generic architectures, making them more flexible and cost effective. Service Providers are expected to invest over USD18 billion in total for SDN and NFV by 2020[6].

Other trends that are becoming more prevalent:

i. The shift to **pay-per-use models** where Enterprises pay for only the resources they consume which will require providers of compute, storage and network services to be able to provision and bill flexibly.

ii. The rise in the **demand for bundled services** that combine public cloud applications (SaaS & PaaS) with compute, storage and network services (IaaS) to cut down costs and enable seamless service integration and effective performance management.

iii. **Service Providers' competitive edge** in offering Cloud Services is set to strengthen significantly as more web-based services and applications are accessed on mobile, with increasing emphasis on quality of service and end-user experience.

2. Tier-1 APAC Operator Seeks Solution to Enhance the Delivery of Managed Network Services

A leading Tier-1 Operator in APAC was evaluating new technologies to deliver enhanced managed network services for its Enterprise customers. With the growth in the demand for these services driven by the region's growing consumption of web-based content and applications, the full-fledged telecommunications company embarked on an initiative to enhance the capacity and capabilities of its managed network services, with the aim of positioning itself as the best-in-class provider of next-generation cloud data center services.

As part of this transformation, the Operator identified NFV-based intelligent service orchestration, leveraging SDN and NFV technologies to pioneer the development of a portfolio of managed network services built on a platform that is:

- **Vendor Agnostic**
- **Technology Agnostic**
- *based on* **Zero Touch Provisioning**
- **Highly Scalable**
- **Comprehensive with Rapid Expandability**
- **Self-service-based, with a complete Service Catalog**
- *able to support* **Service Tiering; *and***
- **Cost Effective**

As part of the initiative, the Operator invited vendors to participate in a Proof of Concept (PoC) to validate solutions that will be able to deliver these capabilities.

3. Proof of Concept led by Anuta Networks

In response to the initiative, Anuta Networks in collaboration with the Tier-1 Operator, HPE and Logicalis, a leading IT solutions and managed services provider, conducted a PoC that saw the company validating the first end-to-end Managed Network Service Delivery using the IETF YANG Modeling Framework.

Anuta Networks deployed its NFV Orchestrator and VNF Lifecycle Manager - **Anuta NCX** - which provides carrier-grade NFV orchestration for instantiating, managing, and chaining Virtual Network Functions (VNFs) in accordance to IETF's Management and Orchestration (MANO) guidelines. The PoC was aimed at demonstrating successful integration of Anuta NCX to a multi-vendor NFV architecture, validating its capability to deliver an end-to-end deployment for NFV in a data center environment.

a. Key Components in the PoC

The following were the components used in the PoC:

Generic Component	Equipment Deployed
NFV Orchestrator	Anuta NCX
VNF Lifecycle Manager	Anuta NCX
SDN Controller	HPE DCN VSD Controller
Multi-Vendor VNFs	HPE VRS GW, F5 BIG-IP LTM VE, Checkpoint R77.30, Fortigate vFW
Virtual Infrastructure Manager (VIM)	HPE Helion Carrier Grade (HCG) Openstack 2.0
Element Management System (EMS)	F5 BIG-IQ, Checkpoint R80 Management
NFV Infrastructure (NFVI)	HPE servers running KVM

b. The Architecture

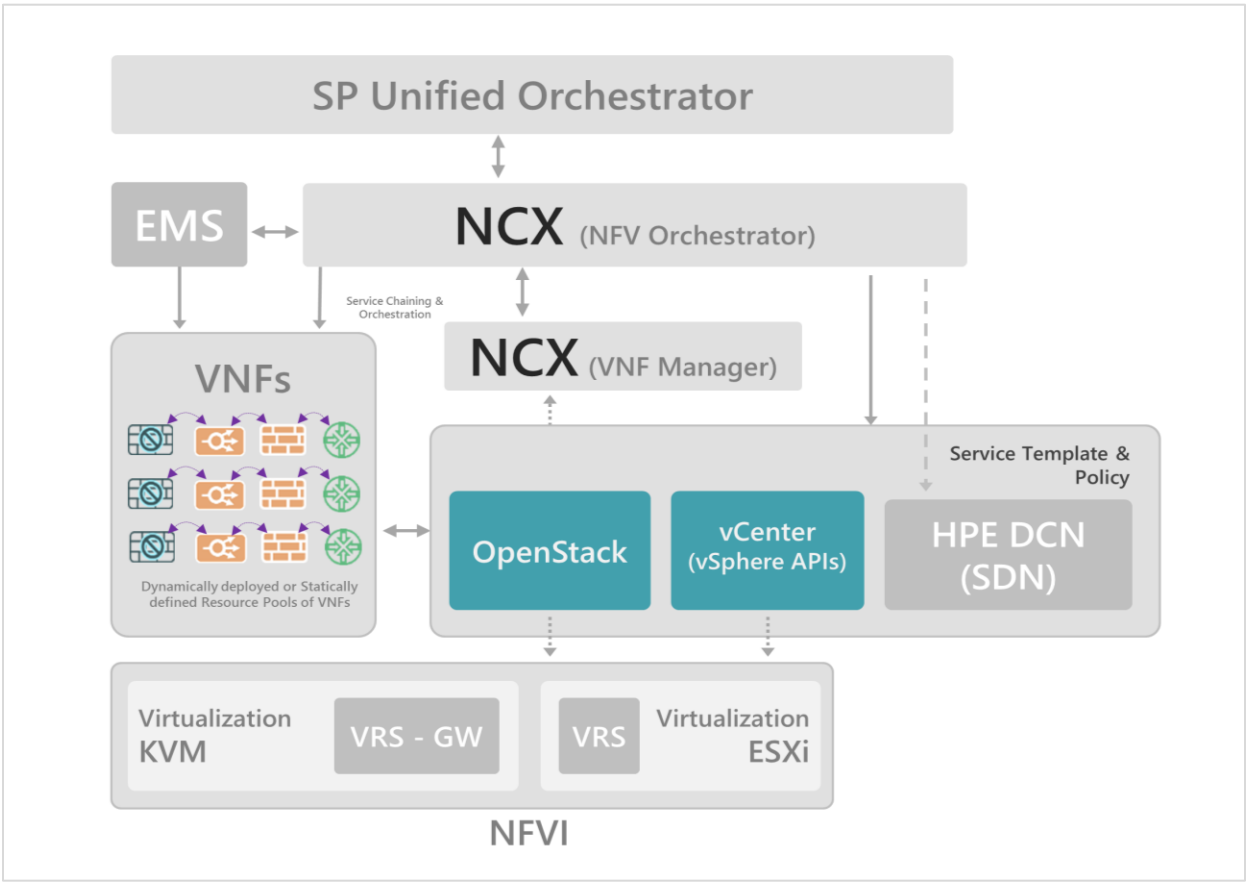

Diagram-1: PoC Reference Architecture

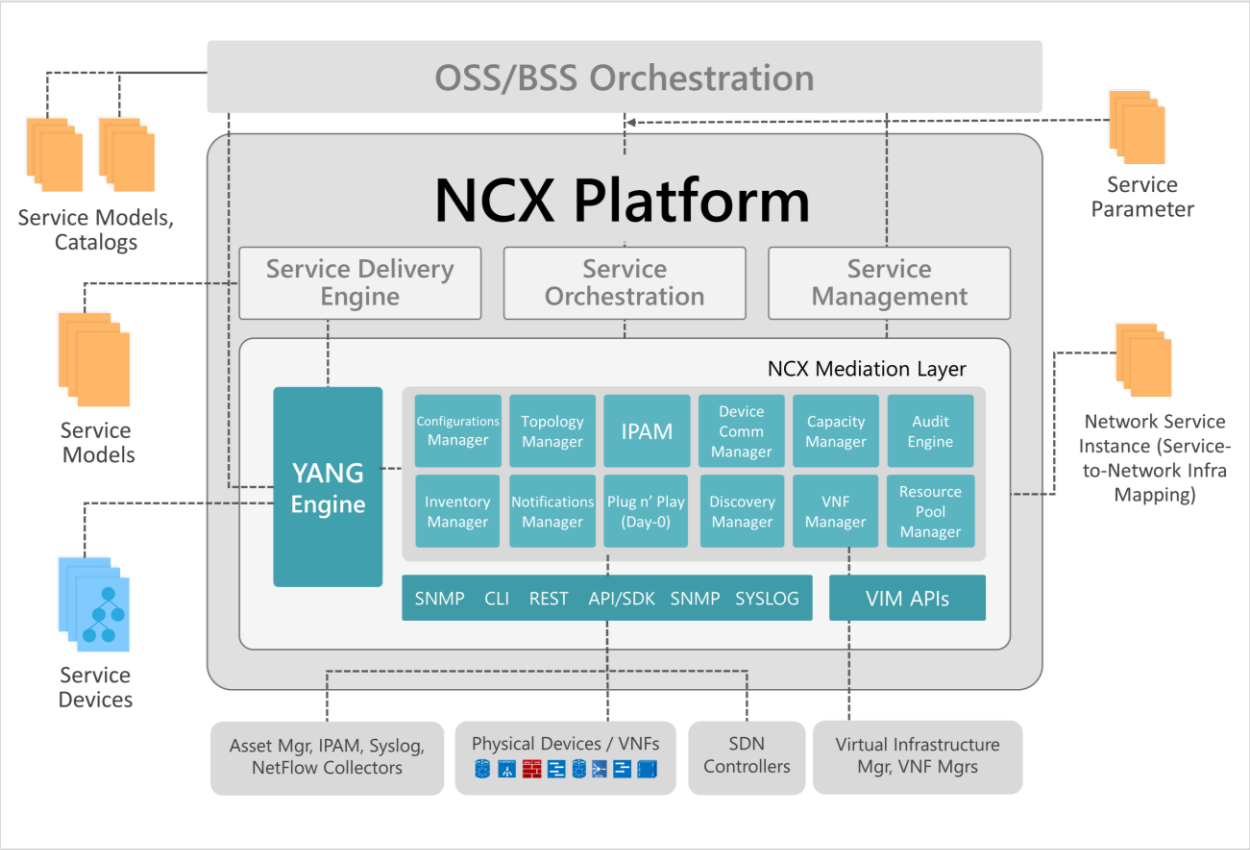

Diagram-2: NCX Detailed Architecture

- **Rich YANG model-driven architecture -** used for Lifecycle Service Orchestration and is the underlying model for customization of advanced workflows, rapid tenant on-boarding, L4-L7 automation, Self-Service, Capacity Management, RBAC and KPI driven orchestration.
- **South Bound Extensibility** – connects to basic device models, common network operations, notifications and others, with extendability to client's own device models or Anuta provided models.
- **North Bound Abstraction** – provides cloud and other north bound orchestration tools to utilize a normalized network service operation model for major functionalities including Firewall, ADC, IPS, VPN and others.
- **Self-service leveraging RESTful APIs and model-driven templates** - used to integrate to OSS, BSS and Self-Service Portals.

c. Service Provisioning and Management

During the PoC, the service orchestration suite from Anuta Networks successfully demonstrated the following results:

1. The implementation of NFV-based service orchestration and VNF Management featuring:
   - Integration with Helion Open Stack, VRS GW, HP EMS and HP VIM;
   - Orchestration of multi-vendor VNFs on Multi-Vendor VIMs (ESXi, OpenStack, KVM);
   - Out of the box support for VNFs from F5, HPE and OpenStack and the ability to rapidly instantiate, manage, and chain VNFs from other vendors; *and*
   - Integration with OSS/BSS including capture of billing data and integration with analytics.
2. Creation of service and device models to support managed network services use cases in a data center using the YANG based model and comprehensive REST APIs;
3. Definition of various levels of network services via combination of L2-L7 network functions using an intuitive graphical designer tool;
4. Configuration of VNFs for example Firewall ACL rules, L2-L3 segmentation, enabling VIPs on Load-balancer, configuring Web Acceptable Use policies, enabling WAN Optimization and scaling/downgrading the tenant network using a self-service catalog; and
5. Showcase of Dynamic Service Orchestration based on Key Performance Indicators (KPI).

4. How did Anuta NCX deliver the PoC Objectives?

The PoC showcased the capabilities built-in within Anuta NCX to deliver not just the requirements set by the Operator, but a set of advanced features such as dynamic service orchestration and a high grade of agility that is required for today's multi-tenant cloud data centers.

More importantly, the entire solution was developed in less than 2 weeks and demonstrated a fully integrated, open architecture with seamless interworking between leading platforms and a wide range of virtualized network functions.

The following table summarizes solution capabilities demonstrated by Anuta Networks in response to the Operator's requirements.

Solution Capabilities	Description
Carrier Grade	Anuta NCX is tailored to meet the needs of service providers with stringent SLAs, to enable them to serve both large Enterprises and SMEs across a wide range of sectors and with vastly different computing, storage and network needs, delivered from a common platform.
Multi-vendor Interoperability	Using the rich YANG model, the PoC saw 10 different leading vendors interworking with each other seamlessly. This level of interoperability allows clients to leverage generic IT systems and equipment as well as any pre-existing architecture within data

	centers, overcoming the issue of 'vendor lock-in'. The high degree of compatibility is also evident in the number of multi-vendor VNFs it is able to support, covering the following - Brocade Vyatta, Checkpoint Virtual Firewall, Cisco CSR1000V, Citrix NetScaler VPX, F5 BIG-IP LTM VE, Fortinet vFW, HPE VRS GW, Juniper vSRX, Riverbed Virtual Steelhead and VMware DVS.
Technology Agnostic	The rich YANG model enables Anuta NCX to integrate seamlessly with any platform, device or interface/protocol, delivering a truly open architecture. The RESTful APIs and model-driven templates enables Anuta NCX to integrate with management platforms such as OSS, BSS and Self-Service Portal; and via Southbound Interfaces such as CLI, REST, YANG, NETCONF connects to VNFs, the SDN Controller and VIMs. Anuta NCX also works with legacy, physical and new virtual appliance-based solutions.
Accelerated Tenant On-boarding	Via automated configuration of network services, clients can orchestrate new services across L2-L7 multi-vendor physical, virtual and hybrid networks, delivering virtual network services and on-boarding new tenants within minutes.
High Scalability	Anuta NCX boasts unrivalled scalability via an architecture that is flexible and replicable with the ability to scale up or down. The solution requires only one instance of Anuta's NCX to manage multiple customers' infrastructure. Anuta NCX achieves this by tracking each tenants' resources and tagging them separately.
Efficient Resource Management	Anuta NCX discovers network infrastructure including device type, role, capacity and topology. Network administrators can organize the resources into multiple pods and resource pools for service provisioning. Anuta NCX maintains real-time inventory of physical and virtual network resources and computes capacity and availability for each service offering. Anuta NCX also generates threshold based alerts to inform the impacted tenants.
Service Expandability	With the use of extensible YANG based model-driven configuration and service management engine to manage multi-vendor devices, Operators can continuously enrich their portfolio of VNFs for new sets of network services, providing a comprehensive and up-to-date service catalog.
Full Self-service Capability	Anuta NCX enables administrators to provision any network service within minutes. Using an intuitive graphical designer, they can define the various levels of network services required while providing tenant admins the tools to self-manage a range of operations, including high frequency operations such as adding or modifying ACLs, NAT rules, VIPs, Real Servers etc. Self-service capability circumvents cumbersome ticketing processes.
Service Tiering	Through dynamic allocation of resources, Anuta NCX is able to create tiered levels of service defined by parameters such as availability and performance. This allows Operators to create differentiated classes of service, for example 'production grade' or 'prototype grade' that are able to match exactly the computing, storage and network needs of each customer.
Complete Lifecycle Management for VNFs	Anuta NCX delivers complete life cycle management for VNFs, regardless of vendors, covering instantiation, placement, image management, service definitions, provisioning, commissioning and decommissioning. This helps Operators activate and terminate services in a timely manner in accordance to their clients' requirements.

Cost Effectiveness	The Yang based model driven architecture used in Anuta NCX allows Operators to substantially lower their Capex, Opex and TCO.
Standards Compliance	Anuta NCX is an open platform, developed in line with IETF NFV MANO guidelines.
Security in a Multi-Tenancy Environment	Anuta NCX offers comprehensive role based access control and integrates with Active Directory (AD) and Lightweight Directory Access Protocol (LDAP) to enforce authorization policies.

First of its kind, the highly successful PoC demonstrated capabilities of Anuta Networks via its NCX solution to deliver carrier-grade NFV orchestration for instantiating, managing, and chaining VNFs, while dynamically and intelligently provisioning computing, storage and networking resources to enable the Tier 1 Operator to efficiently deliver next-generation cloud services to clients across the region.

About Anuta Networks

Anuta Networks is the industry-first provider of end-to-end network services orchestration solutions for large, medium enterprises and service providers. The Company's Network Services orchestration solutions help organizations of all sizes accelerate deployments of network infrastructures and bring agility to the network. Anuta Networks' partnerships with industry leaders such as Cisco Systems, F5 Networks, VMware and many others further enable customers to rapidly transform their network services in agile infrastructure deployments. The Company is headquartered in Silicon Valley with offices in Japan, Australia, Ireland, France, Spain and India.

Reference: [1]***Statista;*** [2]***Statista;*** [3]***Grand View Research*** *- Enterprise Application Market Analysis(Dec 2015);* [4]***IDC*** *- Worldwide Semiannual Public Cloud Services Spending Guide(Jan 2016);* [5]***IHS Research*** *- Carrier SDN Market Size and Forecast Report 2016;* [6]***SNS Research*** *- The SDN, NFV & Network Virtualization Ecosystem: 2016 – 2030*